

## ROUND 1

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### TOSS-UP

1) BIOLOGY *Multiple Choice* Glucose is an example of what class of sugars?

- W) Hexose
- X) Pentose
- Y) Tetrose
- Z) Dextrose

ANSWER: W) HEXOSE

### BONUS

1) BIOLOGY *Short Answer* Name two cellular organelles besides the nucleus that contain a genome.

ANSWER: CHLOROPLAST, MITOCHONDRIA

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### TOSS-UP

2) PHYSICS *Multiple Choice* A train approaches a station with a velocity of +15 meters per second relative to the ground. If a person on the train is moving towards the rear of the train at a speed of 1.5 meters per second relative to the train, what is the velocity, in meters per second, of the person relative to the ground?

- W) +13.5
- X) - 13.5
- Y) +16.5
- Z) -16.5

ANSWER: W) +13.5

### BONUS

2) PHYSICS *Short Answer* A set of non-zero vectors is added to obtain a sum of zero. What is the minimum number of vectors in the set if they are a) equal in magnitude or b) unequal in magnitude?

ANSWER: EQUAL = 2; UNEQUAL= 3

### TOSS-UP

3) MATH *Multiple Choice* Which of the following relations does NOT represent a function?

- W)  $\{(2, 3), (-4, 3), (7, 3)\}$
- X)  $\{(0, 0), (-1, -1), (2, 2)\}$
- Y)  $\{(2, 3), (-5, 3), (2, 7)\}$
- Z)  $\{(-1, 3), (-5, 3), (-9, 0)\}$

ANSWER: Y)  $\{(2, 3), (-5, 3), (2, 7)\}$

### BONUS

3) MATH *Short Answer* How many distinct signals can be made using four flags of different colors on a vertical flagpole?

ANSWER: 24

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### TOSS-UP

4) ENERGY *Multiple Choice* Which of the following is NOT a result of mountaintop coal mining?

- W) Increased mineral content in valley streams
- X) Formation of new wetlands
- Y) Reduction in amphibian populations
- Z) Defragmentation of forests

ANSWER: Z) DEFRAGMENTATION OF FORESTS

### BONUS

4) ENERGY *Multiple Choice* Lithium thionyl **[THY-uh-nil]** chloride batteries have low current delivery but long life spans. They are able to operate at a temperature range between  $-55^{\circ}$  Celsius and  $150^{\circ}$  Celsius. Which of the following is least likely to be powered by a lithium thionyl chloride battery?

- W) Speakers
- X) Smoke detectors
- Y) Diving equipment
- Z) Wireless alarm systems

ANSWER: W) SPEAKERS

### TOSS-UP

5) EARTH AND SPACE *Multiple Choice* What cloud type is characterized by a formless cloud layer that is almost uniformly dark gray?

- W) Cumulonimbus [*kyoo-myuh-loh-NIM-buhs*]
- X) Altocirrus
- Y) Cumulus
- Z) Nimbostratus [*nim-boh-STRAT-uhs*]

ANSWER: Z) NIMBOSTRATUS

### BONUS

5) EARTH AND SPACE *Short Answer* What is the term for a ridge of till that is formed when the lateral moraines of two adjacent alpine glaciers coalesce [*koh-uh-LES*]?

ANSWER: MEDIAL MORaine

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### TOSS-UP

6) CHEMISTRY *Multiple Choice* Your research results in a new surface temperature probe to obtain data on planet Mercury; however, the probe is highly reactive with chalcogen gases. Which of the following would best insulate the probe?

- W) Diatomic fluorine
- X) Diatomic chlorine
- Y) Diatomic oxygen
- Z) Helium

ANSWER: Z) HELIUM

### BONUS

6) CHEMISTRY *Short Answer* If 35 liters of neon gas at 77° Celsius is cooled, the volume drops to 10 liters. If the pressure remains constant, what is the final temperature of the gas, in degrees Celsius?

ANSWER: -173°

### TOSS-UP

7) BIOLOGY *Multiple Choice* What osteichthyes [**os-tee-*IK*-thee-eez**] was known from the fossil record for nearly 100 years before a living specimen was discovered?

- W) Australian lungfish
- X) Beluga sturgeon
- Y) Coelacanth [**SEE-luh-kanth**]
- Z) Bowfin

ANSWER: Y) COELACANTH

### BONUS

7) BIOLOGY *Short Answer* An athlete who normally has plenty of endurance is admitted to the emergency room with symptoms of sickle cell anemia, which include pain crisis in multiple limbs from lack of oxygen as a result of a track competition at high altitude. Suspecting sickle cell trait, doctors decide to screen the athlete's beta-globin gene for sickle-cell mutations. What is the general genetic term that would best describe the athlete's beta-globin genotype of the alleles being tested?

ANSWER: HETEROZYGOUS

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### TOSS-UP

8) PHYSICS *Short Answer* The breakdown electric field of air is approximately 3 million volts per meter. Providing your answer in scientific notation, if a typical storm cloud is at an altitude of 2,000 meters, what is the voltage drop between the ground and the storm cloud just before the lightning strike?

ANSWER:  $6 \times 10^9$

### BONUS

8) PHYSICS *Multiple Choice* A circuit consists of 5 capacitors of 5 microfarads each and a voltage source of 20 volts. If the capacitors are connected in series, what is the potential difference across each of them?

- W) 4 microvolts
- X) 4 volts
- Y) 10 volts
- Z) 20 volts

ANSWER: X) 4 VOLTS

**TOSS-UP**

9) MATH *Multiple Choice* What is the value of  $(i)^{21}$ ?

- W)  $-i$
- X)  $i$
- Y)  $-1$
- Z)  $1$

ANSWER: X)  $i$

**BONUS**

9) MATH *Multiple Choice* Which of the following is equivalent to  $(a^{-1} + b^{-1})^{-1}$  [**open parenthesis a to the power of negative 1 plus b to the power of negative 1 close parenthesis to the power of negative 1**]?

- W)  $\frac{ab}{(a+b)}$  [**the fraction with numerator  $ab$  and denominator  $a$  plus  $b$** ]
- X)  $a + b$
- Y)  $a^2b^2$
- Z)  $ab$

ANSWER: W)  $\frac{ab}{(a+b)}$

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**TOSS-UP**

10) ENERGY *Multiple Choice* Which of the following sources gives the largest amount of radiation exposure?

- W) A transcontinental airline flight
- X) A chest X-ray
- Y) Natural background radiation for one year
- Z) Living within 50 miles of a nuclear power plant for one year

ANSWER: Y) NATURAL BACKGROUND RADIATION FOR ONE YEAR

**BONUS**

10) ENERGY *Multiple Choice* Fuel cells operating on methanol and air produce heat, electricity, and which of the following?

- W) Carbon monoxide
- X) Water
- Y) Water and carbon dioxide
- Z) Mercury

ANSWER: Y) WATER AND CARBON DIOXIDE

### TOSS-UP

11) EARTH AND SPACE *Multiple Choice* Who was the 18th century geologist who first developed the concept of uniformitarianism?

- W) Cuvier [**KYOO-vee-ay**]
- X) Lyell [**LY-uhl**]
- Y) Hutton
- Z) Steno

ANSWER: Y) HUTTON

### BONUS

11) EARTH AND SPACE *Short Answer* What is the chemical formula for the substance whose dissolution was mainly responsible for the formation of Carlsbad Caverns in New Mexico?

ANSWER: CaCO<sub>3</sub>

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### TOSS-UP

12) CHEMISTRY *Multiple Choice* You are asked to investigate a gaseous sample that is composed of a variety of different atmospheric gases. Which of the following gas laws could provide information about the relative composition of the gases?

- W) Avogadro's law
- X) Boyle's law
- Y) Dalton's law of partial pressure
- Z) Charles's law

ANSWER: Y) DALTON'S LAW OF PARTIAL PRESSURE

### BONUS

12) CHEMISTRY *Short Answer* Put the following four compounds in order from least to most covalently bonded: 1) beryllium sulfide, 2) lithium oxide, 3) magnesium chloride, 4) calcium bromide.

ANSWER: 2, 3, 4, 1 (ACCEPT: LITHIUM OXIDE, MAGNESIUM CHLORIDE, CALCIUM BROMIDE, BERYLLIUM SULFIDE)

### TOSS-UP

13) BIOLOGY *Short Answer* If a trace amount of blood was discovered at a crime scene, what technique could be used to amplify the amount of DNA present in this sample, thereby allowing scientists to determine the individual's blood type?

ANSWER: POLYMERASE CHAIN REACTION (ACCEPT: PCR)

### BONUS

13) BIOLOGY *Multiple Choice* Which of the following best explains the property of TAQ polymerase [***tak pol-UH-muh-rays***] that makes it ideal for use in PCR reactions?

- W) It is heat-stable
- X) It is resistant to mechanical perturbation
- Y) It can remain stable at a variety of pH levels
- Z) It can be used in low concentrations

ANSWER: W) IT IS HEAT-STABLE

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### TOSS-UP

14) PHYSICS *Multiple Choice* One hundred resistors have minimum, mean, and maximum values of 110 ohms, 150 ohms, and 300 ohms, respectively. If all 100 resistors are connected in parallel, which of the following ranges could contain the equivalent resistance?

- W) The provided information is insufficient to answer the question
- X) Less than 110 ohms
- Y) More than 110 ohms but less than 300 ohms
- Z) More than 300 ohms

ANSWER: X) LESS THAN 110 OHMS

### BONUS

14) PHYSICS *Short Answer* The breakdown electric field of air is approximately 3 million volts per meter. Assuming that lightning moves uniformly through a cylinder of air with a cross-sectional area of 1 square meter and providing your answer in scientific notation with one significant digit, if a typical storm cloud is at an altitude of 2,000 meters and the resistivity of air is about 10 ohm-meters at breakdown, what is the current in amperes of a cloud-to-cloud lightning strike?

ANSWER:  $3 \times 10^5$

### TOSS-UP

15) MATH *Multiple Choice* If  $f(x) = \sin^2x + \cos^2x$  [**f of x equals sine squared of x plus cosine squared of x**], what is  $f'(x)$  [**f prime of x**]?

W) 0

X) 1

Y)  $2\sin x \cos x$  [**2 sine of x cosine of x**]

Z)  $\sin 2x$  [**sine of 2x**]

ANSWER: W) 0

### BONUS

15) MATH *Multiple Choice* What is the volume of a cube that has a space diagonal of  $3\sqrt{3}$ ?

W) 27

X)  $27\sqrt{3}$

Y) 54

Z) 81

ANSWER: W) 27

### TOSS-UP

16) ENERGY *Short Answer* What physical property is exploited when separating volatiles via fractional distillation?

ANSWER: BOILING POINT (ACCEPT: BOILING TEMPERATURE, VAPOR PRESSURE)

### BONUS

16) ENERGY *Short Answer* At 23° Celsius and 1 atmosphere, what are the physical states, respectively, of ethane, butane, and octane?

ANSWER: ETHANE = GAS, BUTANE = GAS, OCTANE = LIQUID

### TOSS-UP

17) EARTH AND SPACE *Multiple Choice* Which of the following faults forms in areas characterized by extensional tectonics?

- W) Normal
- X) Reverse
- Y) Thrust
- Z) Strike slip

ANSWER: W) NORMAL

### BONUS

17) EARTH AND SPACE *Multiple Choice* The Philippines formed from tectonic activity at which of the following plate boundary types?

- W) Continent-continent convergent
- X) Divergent
- Y) Ocean-ocean convergent
- Z) Transform

ANSWER: Y) OCEAN-OCEAN CONVERGENT

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### TOSS-UP

18) CHEMISTRY *Multiple Choice* Which of the following does NOT have an index of hydrogen deficiency of 3?

- W) Spiropentane [*spy-roh-PEN-tayn*]
- X) Norbornene [*nohr-bohr-NEEN*]
- Y) 1,3-cyclohexadiene [*1 comma 3-sy-kloh-HEK-suh-deen*]
- Z) *trans*-1,3,5-hexatriene [*trans-1-comma-3-comma-5-hek-SUH-treen*]

ANSWER: W) SPIROPENTANE

### BONUS

18) CHEMISTRY *Short Answer* What is the oxidizing agent typically used in hydroboration-oxidation?

ANSWER: HYDROGEN PEROXIDE (ACCEPT: HYDROPEROXIDE ANION, H<sub>2</sub>O<sub>2</sub>)

### TOSS-UP

19) BIOLOGY *Multiple Choice* Which of the following is NOT a characteristic of diatoms?

- W) They have a saccharide cell covering
- Y) They have a frustule [**FRUHS-chool**] made up of silica
- X) They contain carotenoids [**kuh-ROT-n-oids**], as well as chlorophyll a and b
- Z) Some species produce toxins

ANSWER: W) THEY HAVE A SACCHARIDE CELL COVERING

### BONUS

19) BIOLOGY *Short Answer* What term, derived from the Greek words for feces and rock, applies to fossilized animal dung?

ANSWER: COPROLITE

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### TOSS-UP

20) PHYSICS *Multiple Choice* The triple point of water is nearest which of the following temperatures?

- W) 273° Fahrenheit
- X) 273° Celsius
- Y) 273 Kelvin
- Z) 0 Kelvin

ANSWER: Y) 273 KELVIN

### BONUS

20) PHYSICS *Multiple Choice* A pipe with a 30 centimeter inner radius is connected to a pipe with a 15 centimeter inner radius. If incompressible water flows through the pipes, what is the flow speed in centimeters per second in the smaller pipe if the flow speed through the larger pipe is 10 centimeters per second?

- W) 10
- X) 20
- Y) 30
- Z) 40

ANSWER: Z) 40

**TOSS-UP**

21) MATH *Short Answer* Solve the following equation for  $x$  over the real numbers:  $27(3^x) = 81$   
**[27 times 3 to the power of  $x$  equals 81].**

ANSWER: 1

**BONUS**

21) MATH *Short Answer* If the first four terms of an arithmetic sequence are  $a$ ,  $2a$ ,  $b$ , and  $a - 6 - b$ , find the 100<sup>th</sup> term.

ANSWER: -100

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**TOSS-UP**

22) EARTH AND SPACE *Multiple Choice* The lack of transmission of earthquake S-waves through what layer of the Earth is evidence that it is liquid?

- W) Mantle
- X) Outer core
- Y) Inner core
- Z) Lithosphere

ANSWER: X) OUTER CORE

**BONUS**

22) EARTH AND SPACE *Multiple Choice* Nimbostratus [**nim-boh-STRAT-uhs**] clouds are considered what type of clouds, based on their height in the atmosphere?

- W) High-level
- X) Mid-level
- Y) Low-level
- Z) Ground-level

ANSWER: Y) LOW-LEVEL

### TOSS-UP

23) CHEMISTRY *Multiple Choice* What is the major product in the ethoxide-promoted  $\beta$  [**beta**]-elimination of 1-chloro-1-methylcyclohexane [**1-chloro-1-meth-uhl-sy-kluh-HEK-sayn**]?

- W) Ethanol
- X) 1-methyl-1-cyclohexene [**1- methyl-1-sy-kluh-HEK-sayn**]
- Y) Methylcyclohexane
- Z) Methylenecyclohexane [**METH-uh-leen-sy-kluh-HEK-sayn**]

ANSWER: X) 1-METHYL-1-CYCLOHEXENE

### BONUS

23) CHEMISTRY *Short Answer* Which halogen is the poorest  $S_N2$  leaving group?

ANSWER: FLUORINE

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### TOSS-UP

24) BIOLOGY *Multiple Choice* In a gel electrophoresis [**i-lek-troh-fuh-REE-sis**] experiment, in which of the following directions will a DNA sample move, and why?

- W) Toward the negative electrode because DNA has a positive charge
- X) Toward the negative electrode because DNA has a negative charge
- Y) Toward the positive electrode because DNA has a positive charge
- Z) Toward the positive electrode because DNA has a negative charge

ANSWER: Z) TOWARD THE POSITIVE ELECTRODE BECAUSE DNA HAS A NEGATIVE CHARGE

### BONUS

24) BIOLOGY *Multiple Choice* Which of the following chemical bonds does NOT correctly characterize the interaction between two molecules?

- W) Ester linkage: ribose to phosphate
- X) Peptide bond: amino acid to amino acid
- Y) Covalent bond: anticodon to codon
- Z) Hydrogen bond: adenine [**AD-n-een**] to thymine [**THY-meen**]

ANSWER: Y) COVALENT BOND: ANTICODON TO CODON

### TOSS-UP

25) PHYSICS *Multiple Choice* A spaceship going away from you at a speed  $0.2c$  sends an electromagnetic signal to you. What is the speed at which the signal approaches?

- W)  $0.2 c$
- X)  $0.8 c$
- Y)  $c$
- Z)  $1.2 c$

ANSWER: Y)  $c$

### BONUS

25) PHYSICS *Multiple Choice* A box slides with friction up a ramp, comes to rest briefly, and then slides back down. Which of the following statements about this motion is true?

- W) The magnitude of the acceleration of the box at any point sliding up the ramp is greater than the magnitude of the acceleration at the same point down the ramp
- X) The magnitude of the acceleration of the box at any point sliding down the ramp is greater than the magnitude of the acceleration at the same point up the ramp
- Y) The magnitude of the acceleration of the box at any point sliding up the ramp is the same as the magnitude of the acceleration of the box at the same point down the ramp and is non-zero
- Z) The magnitude of the acceleration of the box at any point sliding up the ramp is the same as the magnitude of the acceleration of the box at the same point down the ramp and is zero

ANSWER: W) THE MAGNITUDE OF THE ACCELERATION OF THE BOX AT ANY POINT SLIDING UP THE RAMP IS GREATER THAN THE MAGNITUDE OF THE ACCELERATION AT THE SAME POINT DOWN THE RAMP